Effects of Seismic Exploration on Pygmy Rabbits

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ABSTRACT

Pygmy rabbit behavior and above ground burrow characteristics were monitored during seismic exploration in northern Utah in the fall of 2008. Burrow entrance characteristics (height and width) were evaluated at distances up to 250 m from the geophone line before and after the seismic survey. Burrow heights after the seismic survey were significantly lower than pre-treatment measurements ≤25m from the geophone line, but were unchanged at farther distances. Burrow height was reduced by minor sloughing presumably caused by sonic vibrations emitted by vibroseis trucks. Burrow entrances were collapsed if they received a direct hit by a vibroseis tire or shaker pad. Radio collared pygmy rabbits living near the seismic activity were not displaced from their home ranges by the seismic exploration. Vibroseis tracks typically extended an average of 16 m on either side of the geophone line, and most burrow effects were experienced within ~10 m of this impact zone. A 50m buffer around known active burrow sites is therefore sufficient to prevent damage to pygmy rabbit burrows by seismic exploration. Further studies are needed to evaluate the effects of seismic exploration on rabbits living in the direct path of seismic activity.

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INTRODUCTION

Oil and gas exploration and development are rapidly expanding worldwide. The process of locating and assessing subterranean oil and gas (termed seismic exploration) consists of mapping of the potential resource field with controlled acoustic energy recorded by a network of receivers (geophones) that are placed along transects, hereafter called geophone lines. Seismic energy transmitters are mounted on large trucks (vibroseis), which generate a vibratory force through a plate that is placed in contact with the ground. Four vibroseis trucks travel abreast on both sides of the geophone line, stopping at regular intervals to transmit vibrations. Dynamite is used to create acoustic energy in locations that are inaccessible to vibroseis trucks. While the influence of oil and gas development on terrestrial wildlife is well studied (for example: Cameron et al. 1992; Lyon and Anderson 2003; Sawyer et al. 2006), the effects of terrestrial seismic exploration activities are little understood.

Seismic exploration has the potential to affect wildlife either by increasing noise and activity around them, or through long-term habitat alteration. The footprint of exploration activities can be quite large (Jorgenson et al. 2010), though the exploration activity itself is relatively brief (weeks to months). To date, most terrestrial seismic exploration studies have occurred in the tundra, prairies, and forests of far northern latitudes. In the far north, seismic exploration can alter plant community structure, cause soil compaction, and accelerate loss of permafrost (Felix and Raynolds 1989), and these effects can be long-term (Jorgenson et al. 2010). The long-lasting linear remnants of seismic exploration in the arctic have been shown to affect bird distribution and nest success (Ashenhurst and Hannon 2008). There is evidence to suggest wildlife may react to seismic activity with elevated metabolic rates (Bradshaw et al. 1998; Reynolds et al. 1986), and the cumulative effects of repeated disturbance of individuals may affect population reproductive rates if exploration is widespread (Bradshaw et al. 1998).

In October 2008 a seismic exploration operation was conducted in the Duck Creek grazing allotment in northern Utah, USA. The route of the survey bisected a site that was part of on-going investigations of pygmy rabbit (*Brachylagus idahoensis*) behavior and ecology. At the time of the exploration, pygmy rabbits were petitioned to be listed under the Endangered Species Act (U. S. Fish and Wildlife Service 2008). In 2010 pygmy rabbits were deemed not warranted for protection under the ESA (U. S. Fish and Wildlife

Service 2010). Pygmy rabbits are associated with dense sagebrush (*Artemisia tridentata* ssp.), and self-created burrow systems (Green and Flinders 1980). While aboveground resources are certainly important for pygmy rabbits, the effects of seismic energy on burrow systems could affect pygmy rabbits by altering burrow architecture, and if severe, trapping them inside collapsed burrows. The objectives of this study were three-fold: 1) to monitor the effects of vibroseis activity burrow entrance architecture; 2) monitor the behavior of radio-collared pygmy rabbits during exploration activities; 3) evaluate the efficacy of a 50-m mitigation buffer.

METHODS

The study was conducted in Rich County, Utah, USA. The site ranged in elevation from 1800 m to 2300 m and consisted of rolling hills with small drainages, some with spring-fed perennial streams. The climate was characteristic of shrub-steppe vegetation types consisting of cold winters, warm summers, and most precipitation falling as winter snow (West and Young 2000). Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) was dominant, with basin big sagebrush (*A.ttridentata* ssp. *tridentata*) and low sagebrush (*A. arbuscula*) present at much lower frequencies. Snowberry (*Symphoricarpos oreophilus*) was co-dominant with sagebrush on more mesic aspects. The under-story contained a diverse mix of small shrubs, grasses and forbs, both native and non-native. Land was mixed ownership (Bureau of Land Management and private).

The present study occurred on a 7.3 km (4.5 mi) segment of the seismic route. At the time of the seismic survey, pygmy rabbit investigations had been conducted for several years prior, and were to continue for another several months. As part the on-going study, 16 adult pygmy rabbits (11 Females and 5 males) were captured at burrow sites in spring 2008, and monitored weekly prior to the seismic exploration project (for detatils see: Wilson et al. 2011). The geophone line was centered within the area of this existing study (figure 1).

The seismic survey was conducted by CGGVeritas (CGGV, Cedex, France) on 23 and 24 October 2008. Prior to the study, all Federal lands were surveyed for pygmy rabbit burrow activity by a private contractor. As per their agreement with the Bureau of Land Management (BLM), CGGV applied 50-m mitigation buffers around all known pygmy rabbit burrows found by the contractor. In addition, CGGV agreed to apply a similar 50-m mitigation buffer around the minimum convex hull home ranges of the 16 radio-collared pygmy rabbits located within the study area. No exploration activities were conducted within these buffers. Burrow surveys were not conducted on private land.

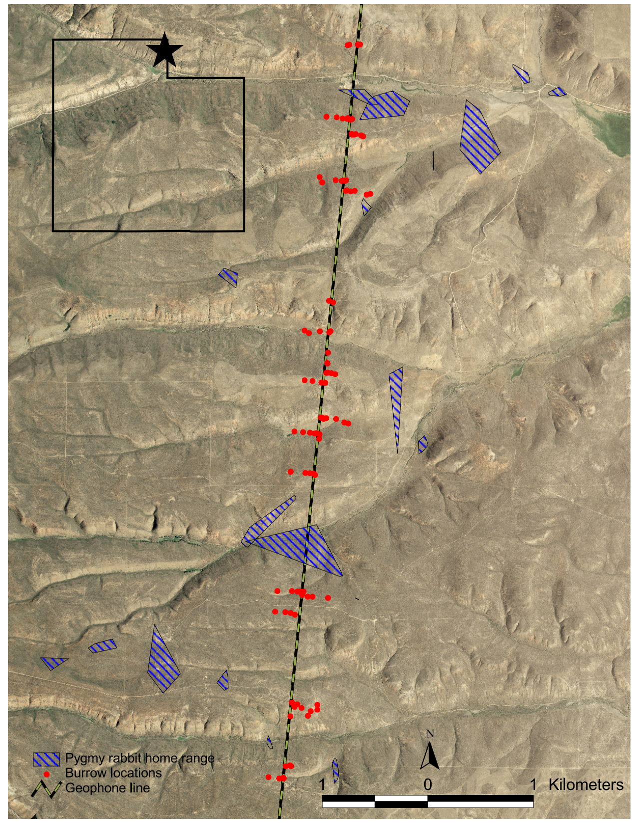

Figure 1. Map of the study area in northern Utah, USA.

Fifteen random vibroseis and five random dynamite locations were selected for burrow measurements. The direction (right or left) of perpendicular burrow transects was randomized based on a coin toss in the field. Burrows were sampled in eight distance classes located along transects at roughly 0, 5, 10, 20, 50, 100, 150, 200, 250 m. In practice burrows weren't always found at every distance class, and all burrows <25 m along the transect were measured. All measured burrows were marked with a metal numbered tag staked near the burrow entrance, flagging tape, and paint so that they could be relocated if collapsed or disturbed during the seismic exploration. Burrows typically enter the ground at an angle; meaning that width and height of the burrow entrance were the most appropriate dimensions for measurement. Burrow width was measured at the largest point in the horizontal dimension at the mouth of the burrow, and burrow height was measured from the floor to the roof of the burrow opening at the tallest spot. The location of each burrow measurement was marked with blue and orange spray paint to ensure repeated measurements were made from the same location. Burrow measurements were made <1 week prior, and <4 weeks after seismic activity. Paired *t* tests were used to compare the change in burrow dimensions between the pre- and post- seismic measurements. Pygmy rabbits were located visually using homing telemetry immediately prior to and immediately after seismic exploration of the site. Four rabbits were monitored continuously when seismic activity occurred near their home ranges.

RESULTS

None of the rabbits left their home ranges despite the fact that two of them were located within 100m of the geophone line. Other rabbits were located near vibroseis trails (termed snail trails) used by the vibroseis trucks to move between access points on the geophone line. A snail trail on an existing 2-track road bisected the home range of one rabbit. Another rabbit was located near (~120 m) a helicopter landing pad and staging area that was used by CGGV crews for about 2 weeks before and after the survey was conducted on the study area.

Vibroseis vehicles travelled abreast on both sides of the geophone line. The impact zone of the tracks was between 20.7 and 54.8 m (mean = 32.3, standard deviation = 10.5, n = 16) wide. Burrow entrances were collapsed if they received a direct hit of a vibroseis truck tire, or shaker plate (n = 7). Otherwise, they experienced minor (figure 2), but statistically significant $\mu_D = -2.5$ ($t = -3.080$, $P = 0.004$, DF = 45) reductions in burrow height if they were located ≤25 m of the geophone line. No change in burrow height was observed for burrows >25m from the geophone line. No changes were observed in burrow width.

DISCUSSION

Pygmy rabbits with minimum convex polygon home ranges ≥ 77 m of the geophone line were not displaced by seismic activity. Before and after measurement of burrows occurring ≤ 250m of the geophone line indicated that burrows within the impact zone of the vibroseis trucks (≤25 m from the vibrophone line) experienced minor, but statistically significant changes in burrow height. This was presumably due to the vibrations emitted by the vibroseis trucks. A 50-m buffer was an effective mitigation measure for temporary displacement disturbance and from burrow damage by the seismic activity.

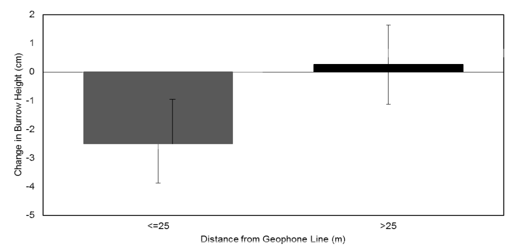

Figure 2. Mean change in height of burrows between the before seismic and after seismic measurements at two distance classes: ≤25 m, and >25 m.

A mean reduction of 2.5 cm in burrow height is not likely to significantly affect the ability of rabbits to use burrows. However, it is not known how deeply the burrows were disturbed. Additional studies are needed to evaluate the impacts of seismic vibrations on the underground portions of burrows. Also, burrow entrances that received a direct hit from a vibroseis truck tire or shaker pad appeared to be collapsed. It is also not known if rabbits potentially trapped inside these collapsed burrows would be able to escape either by using other burrow entrances or digging through the soil and splintered sagebrush blocking the collapsed burrow entrance. The home ranges of all radio-collared pygmy rabbits were excluded from direct disturbance by vibroseis trucks by the 50m mitigation buffer, so it is not known if rabbits living directly in the path of seismic activity would have retreated to a burrow (and thus potentially trapped in a collapsed one), or left the area during activity. These questions should be addressed prior to changing the use of mitigation buffers for pygmy rabbits.

The observed damage to the burrow entrance caused by vibroseis trucks was similar to that caused by sagebrush mechanical treatments. It is common practice when conducting sagebrush treatments to buffer active pygmy rabbit burrows by 50 m. The present study suggests that this buffer distance is also adequate for seismic exploration. However, it should be noted that there is a difference in the application of mitigation buffers for mechanical treatments and that of the seismic lines. No disturbance is allowed within the mitigation buffer of a treatment, whereas only the geophone line (center line) is mitigated for seismic surveys. Seismic exploration disturbances typically extend 16 m (up to 28 m) on either side of the geophone line. This means that while the width of the actual vibroseis disturbance is ensured to be less than the buffer (and burrows are likely minimally impacted), it does not insure that any vibroseis disturbance is ≥50 m from any active burrow. If the intent of applying a mitigation buffer is to insure that there will be at least 50 m between active burrows and the nearest disturbance, then the typical width of vibroseis activity beyond the geophone line should be taken into account when applying mitigation buffers.

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